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Spring 2016

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Recommended Citation

Lamb, Heather, "The Shadow is Revived: Constructing Narratives in Victorian Literature and Science Fiction with Non-Euclidean Mathematics" (2016). *2016 Awards for Excellence in Student Research and Creative Activity - Documents*. 1.
http://thekeep.eiu.edu/lib_awards_2016_docs/1

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The Shadow is Revived: Constructing Narratives in Victorian Literature and Science Fiction with Non-Euclidean Mathematics

I. Introduction: A Brief Guide for Novice Chrononauts and Psychoyagers

“First and foremost, steampunk is about things — especially technological things — and our relationship to them. As a sub-genre of science fiction, it explores the difference an object can make,” says Stefania Forlini in “Technology and Morality: The Stuff of Steampunk” (72). While steampunk literature, and its scholars, focuses heavily upon the anachronistic objects, gadgets, and machines embedded in steampunk narratives, both seem to forget about time itself. Just as Forlini indicates that humans form various relationships to their objects, building identity from and with them, humans must also form a relationship with time. In steampunk, time itself becomes an object that is embedded in narrative. As an object, similar to a machine or a gadget, time can be manipulated and reconstructed. Therefore, steampunk is primarily “about things,” but its primary “object” is time.

To establish a primary object is to then establish the relationship to the object and explore “the difference an object can make.” In steampunk, an object’s user both transfers his own identity to the object and evolves his own from the use of the object. The synergistic transfer of identity can be easily demonstrated with the use of objects considered concrete, such as an aether gun or steam-powered phaeton. The transference of identity between time and man seems problematic, as time is abstract; however, steampunk simplifies the concept by transforming time into an object that works just as a machine. Time becomes a mechanical structure made of separate parts that are removable, replaceable, replicable, yet adaptable and changeable. To label time as an object proves helpful when trying to understand steampunk literature and the human identity in relation to time, but it would be a terrible simplification to render time as just an object. Instead, time becomes both an object and its own entity: Time may be manipulated by both the author and the characters within the story, but time proves to tell its own story and establish its own identity. Time, along with those who use it and are used by it, demonstrates its quality of fluidity, and, therefore, demonstrates the indefiniteness and changeability inherent in human nature.

This study explores the manipulation of time, perspective, and history to demonstrate the fluidity present in identity and representation: Such fluidity is found in Edwin Abbott's Victorian novella *Flatland: A Romance of Many Dimensions* (1884), and Mark Hodder's steampunk novel *The Strange Affair of Spring-Heeled Jack* (2010). Hodder's novel illustrates an apprehension when blending fact with fiction and reality with imagination; however, Hodder's novel ultimately creates a reality in which the blending of these binaries constructs a legitimate world. In fact, the unification of the two, fact and fiction, enriches both.

The idea of imagination working congruently, or parallel, with fact is not new and can be seen in the development of non-Euclidean geometry through the nineteenth century. For non-Euclidean geometers, such as Hermann von Helmholtz and Bernhard Riemann, geometry's system of representation proved insufficient when attempting to describe higher-dimensional space, especially the fourth dimension. Non-Euclidean geometers questioned the value of standard geometric terms and diagrams when the realms being explored and discussed were imperceptible to the eye. The Euclidean structure of representation proved limiting, and non-Euclidean geometers began to describe imaginary geometry in a way that could be constructed and seen by the mind's eye — with words, stories, and analogies. Imaginary geometry combined the power of storytelling with the power of mathematics to form a new kind of space, a higher-dimensional space.

This newly formed system of representation, combining story and mathematics, established several precedents found in both Victorian science fiction, including Abbott's novella, and steampunk literature. Perhaps the mathematical punks of their age, non-Euclidean geometers were criticized for their non-standard ideas and abstract mathematical concepts. To combat such criticism, these geometers found methods of aligning their own systems of representation and geometry into the already-established structures of geometry: They demonstrate their own fluidity of identity by adapting mathematical vocabulary to their own geometric ideas and adjusting the world around them to their own needs. This adaptation establishes a major precedent in imaginative-mathematical narrative, which is that of internal consistency. To establish new systems of representation, one must first demonstrate that the new system

has internal consistency, but that it may also coincide with established and accepted forms of representation. By adjusting an established system to justify a new one, the geometers also institute another standard in imaginative-mathematical narrative, which is to illustrate a different world, or dimension, that does not rebel against an established one; rather, these geometers attempt to display a realm different from the known world. This other world functions under different limitations and laws than our known world, and it also has consistencies and structures just as our own world does. Non-Euclidean mathematicians may call this realm hyperspace, the fourth dimension, a mirror world, a shadow world, or, as Edwin Abbott calls it, “Thoughtland.”

Non-Euclidean mathematics and stories become associated with limitation, the perspective created under specific limitations, and congruence. Charles Howard Hinton, a mathematician and author of *Scientific Romances*, believes that a higher state of mind that can be achieved by opening the mind’s horizons: Horizons are opened by overcoming physical and mental limitations. To pass over a horizon is to pass into a higher state of thinking. Abbott’s protagonist, A. Square, opens his mind by physically passing over a horizon, or ascending momentarily into a three-dimensional world. Abbott’s “Thoughtland” becomes a space where man can overcome his dimensional limitations. A. Square’s limitation is, initially, mental, as he cannot conceive higher space. Once he opens a mental horizon, he is only then limited by his own physical dimensionality.

Abbott’s protagonist poses the question of how to overcome mental and physical dimensionality. By using mathematical concepts and terms, the answer is found in congruence and motion. Gustav Fechner describes a “back and forth” motion of nature, or a fluidity of time (“Space has Four Dimensions”). Abbott illustrates this motion and applies it to dimensionality. Abbott creates a society in which regularity renders a level of intellect and societal position. Non-Euclidean mathematicians, instead of regularity, preferred the term congruency. Both apply to a shape, or individual, fitting into society and representational systems; however, both the mathematicians and their terms suggest deviation. For Abbott, deviation evokes irregularity, of both the body and the mind. Thoughtland becomes a space in which physical and mental limitation are perceived and removed. Ascension into Thoughtland, the

temporary removal of limitation, becomes a perturbation of the mind. However, as Fechner established, nature has a “back and forth” motion. An ascent into Thoughtland necessitates a descent from it. Congruence and internal consistency remain true even when opening horizons of the mind.

Abbott’s novella offers a landscape of the mind and an exploration of its psychology. Similarly, Mark Hodder’s novel investigates the psychological landscape and its close association with time. In *Spring-Heeled Jack*, the combination of fictitious and real creates that momentary perturbation of the mind in which it must see its own limitations, lose itself in unlimited possibilities, reformulate itself to construct a new identity, and descend back into a world of real limitations. Steampunk, as seen in this novel, accepts the non-Euclidean standards of structure, consistency, and congruency: In doing so, the novel demonstrates that a reformulation of identity may require a reconstruction of a system of representation. Such a system may allow for more abstract or more concrete terms to redress a representational deficit: The same system may create some logical, mathematical order into a seemingly chaotic imaginary system.

Time, then, becomes embedded into an imaginary, yet mathematical, structure. Time’s fluidity transfers to the human identity, but the human desire for structure orders time. The two become inseparable, rendering time an essential object in steampunk literature and crucial to human identity. David Fowler, in “Mathematic in Science Fiction: Mathematics as Science Fiction,” argues that “mathematical science fiction then could be described as the intersection of two stories, one of them being a ‘fantastic event’ and the other being some part of the ‘story of mathematics’” (52). Some of the “stories could describe possible connections between perceptual and physical spaces, resulting in a ‘geometrical space’” (Fowler 52). For steampunks and non-Euclidean geometers, the interaction of imagination and mathematics demonstrates, psychologically, the relationship between man, time, and the re-creation of both. The story of mathematics is also the story of imagination: Non-Euclidean narrative is that “fantastic event” where perception and actuality create reality.

II. The World, as it Appears in Spoons and Lawn Ornaments

[This section discusses the openness with which 19th-century mathematicians discussed higher-dimensional space. At the time, geometry and algebra began to borrow language from each other, creating

confusion in the world of mathematics. Simultaneously, geometers began to stray from concrete ideas to pursue the more abstract. Knowing that they were discussing a place that could not be described, they began to use narrative to describe a dimension of existence that could be envisioned through the mind's eye. I have included the conclusion to better understand the following sections. The premise of this section builds from C. P. Snow's lecture, "The Two Cultures," in which he argues that scientists and literary scholars can never coexist peacefully. Mathematics of the 19th century disproves Snow's argument, as literature becomes the means to enrich mathematics and mathematics becomes a system that enriches literature. I connect this to the idea that Herman von Helmholtz presents — hyperspace is similar to a convex mirror, or a garden globe, and the perception of the world changes depending on which side of the glass you inhabit. This is similar to mathematics and literature. Both have a complimentary image, and while some prefer one to the other, both are just as valid as its reflection.]

While hiding abstract concepts under "geometric garb" may help mathematicians explain and understand their own work, as well as fellow mathematicians', narrative assists non-mathematicians in constructing an image of hyperspace in the mind. The abstract finds the structural system of geometry convenient in establishing itself, but geometry finds narrative necessary in areas it cannot explain in geometrics. Just as mathematicians used analogies and miniscule stories to explain a mathematical concept, Edwin Abbott extends this new system of representation to craft his novella *Flatland*. Both the essays and the novella attempt to construct an abstract form in the mind's eye by utilizing a blended system of logic and imagination.

In his address, C. P. Snow describes two cultures that "long ceased to speak to each other" (19). Mathematicians and scientists of the 19th Century show not only interest in communicating with literature through the medium of narrative, but the desire for synergism. These mathematicians hold firmly to congruence, and congruence may be a more fitting term to apply to the general uneasiness surrounding non-Euclidean geometry. At the end of his essay, Riemann directly comments on the criticism he anticipates: "Investigations like the one I just made, which begin from general concepts, can serve only to insure that this work is not hindered by unduly restricted concepts and that progress in comprehending the connection of things is not obstructed by traditional prejudices" (Riemann 33). Riemann describes the "deviation from flatness," or special manifolds, "in which the square of the lines element can be expressed as the sum of the squares of complete differentials" (27). Extending his argument and narrowing the scope of investigation, our three-dimensional world rests on a flat surface, whether or not that surface is part of a larger curved surface. When considering the evolution of this new system of

geometry, and the opposition of the form, “deviation from flatness” may not just be deviation from space, such as our own, but a deviation from both geometric standards, which non-Euclidean geometry proposes, and deviation from accepted societal norms. As Riemann suggests, mathematicians may not be the only individuals who prefer congruency. A geometry that is not congruent with the established principles and accepted standards, a non-Euclidean geometry, is simply too deviant to be readily accepted. Society sees the world in flatness, but slowly and congruently, 19th-Century geometers constructed a new representational system of space through the structure of narrative. Under the standard of congruency, narratives and mathematics must reflect one another. Should one evolve or diverge from the other, its reflection must evolve with it, or diverge in a congruent path. Clifford may not have been entirely correct when believing “this other may be the true state of things,” because he failed to consider congruence and perspective, making both the object and the reflection the “true state of things.” Mathematics and narratives, for non-Euclidean geometers, were simply reflections of one another, or divergent paths that lead to the same conclusion.

The same notions of congruence and representation are illustrated in Edwin Abbott Abbott’s *Flatland* and embedded in time travel narratives, such as Hodder’s *Spring-Heeled Jack*. In these texts, the characters and narratives attempt to manipulate time to deviate from oppressive systems of representation. However, even as these characters, and time as its own entity, attempt to reconstruct themselves and their own system of representation, both time and individual must function under the constraints of a larger established system with definite limitations. In Abbott’s novella, the character must function under an established system of geometric regularity and the limitations of a two-dimensional body. In Hodder’s novel, the characters must function under a system of time that seems chaotic but is ultimately internally regulated by fixed points and standards in time. The two narratives, manipulating time and space, intersect where words, mathematical logic, and imagination converge and immediately diverge — “Thoughtland.”

III. Shadows in the Flatlands

The literary texts that use narrative to explore mathematics, or, rather, use mathematics to enrich narrative, illustrate the same concepts of congruence, perspective, perception, movement, and systematic representation of the abstract. However, the texts, toward the latter half of the century, evolve to anticipate science fiction that not only utilizes movement through time and space, but also uses literary narratives of time and space to mount rebellions of thought and imagination. Mathematicians such as Gustav Fechner and Edwin Abbott portray a landscape of the mind in which the self exists in several different realms. Each realm contains its own specific limitations. Fechner illustrates a desire to differentiate oneself from the self of other realms, and Abbott believes that differentiation can only be achieved by opening mental horizons, as described by Charles Howard Hinton, and momentarily overcoming limitations.

The first attempt to explain the fourth dimension, or hyperspace, through terms more descriptive and abstract than mathematics or mathematical analogy, appeared in Gustav Fechner's "The Shadow is Alive" (1846). Published eight years before Riemann's essay, Fechner defines the relation of a man to his shadow, describing the limitations and advantages of both entities. By giving thought, feeling, and voice to the shadow, Fechner establishes the shadow as a living entity: "Just as man may say that he doesn't believe in the life of his shadow, with equally good reasons the shadow can reply that he doesn't believe in the life of his man" (130). The German physicist and psychologist, like the mathematicians previously mentioned, endeavors to demonstrate the problematic nature of perspective alongside the limitations of man. Just as a living shadow is limited by his own two dimensions, whose "body stands like a wall separating him ['the great Primeval Shadow in the Heavens'] from me [the shadow]" (131), a three-dimensional being is limited by his own dimensions, "which render us thick and rigid" (130). The limitation of perspective is apparent in both of Fechner's essays, as well as the mathematical essays, and the reality of either the shadow or his companion "depends on the point of view" (131). To the shadow, the man "is an imaginary being entirely dependent" upon the shadow: The man is simply a "crude imitation" (131).

Although Fechner's "imitation" seems to draw upon the Helmholtz's convex mirror, two congruent bodies and realms separated by the boundary of a mirror, Fechner's ideas of congruence suggest balance in opposition. Fechner does create some congruence by constructing a two-dimensional creature that responds to three-dimensional men in "equivalent arguments" (130). The shadow can be nothing but congruent to what casts it: "Neither a genius nor a fool can behave differently than his shadow" (130). After establishing the congruence between man and his shadow, considered a "constant companion dependent upon us" (131), Fechner repeatedly proves that the shadow is not only an independent being, but the shadow's perspective and creation is "the reverse of our positive being" (130). To form a shadow in a two-dimensional world, a light must be present in a three-dimensional realm: "our body must provide residence and nourishment for one spirit (the soul) and give light to another (the shadow) – to be sure, not positively but negatively, that is, to supply the necessary absence of light" (131). Fechner presents two realms whose existences are dependent upon one another, but they are entirely distinct from one another due to perspective and physical construction. The concept may appear in opposition to congruence, but Fechner's opposition creates the balance that the mathematical principle demands: "We see everywhere that the same material can serve very different spirits. The moon must give us light and the same time provide a place of residence and nourishment for its inhabitants" (130).

A three-dimensional being, then, can serve his own purposes in his own realm, but also serve a function in the shadow's realm. One being simply cannot function without the existence of the other: "A positive being is inconceivable without the contrast provided by a negative being: it owes its illusory existence to its antithesis" (131). Where mathematicians find congruence in exact parallels, Fechner explains congruence as the balance of reverse imaging, antithesis, or equal opposition: "What is more distinct than the contrast between shadow and the surrounding light" (131).

Fechner's essay, reprinted in 1875, serves as a precursor to one of the most important literary texts discussing the fourth dimension, Edwin Abbott's *Flatland* (1884). *Flatland* captures the spirit found in Fechner's work and the logical structure instituted in the mathematically focused essays. The foundation of the novel progresses toward Fechner's ideal of congruence and opposition.

Where Fechner uses “antithesis” and mathematicians utilize “congruence,” A Square, the protagonist of *Flatland*, utilizes the term “Regular.” The structure of Flatland’s society, the class system, is based upon the regularity of the geometrical figure’s figure: “Flatland rests upon the fundamental fact that Nature wills all Figures to have their sides equal” (23). Geometric figures “found to exceed the fixed margin of deviation” are either closely controlled or destroyed (24). In Flatland, the “deviation from flatness” that Riemann describes, and previously suggested to be deviation from societal norms, holds true. Deviation from both physical regularity and societal regularity, or accepted beliefs, proves unacceptable. By the conclusion of the novella, A Square, who preaches the truth of higher dimensions, confronts “years of imprisonment, and the still heavier burden of general incredulity and mockery?” (viii). The “single maxim” of Flatland, “Attend to your Configuration,” structures A Square’s society and its congruent counterpart, the society of non-Euclidean mathematicians. In Flatland, “all faults or defects from the slightest misconduct to the most flagitious crime” is “attributed to some deviation from perfect regularity in the bodily figure” (37). Since the body in Flatland is a reflection of the mind, an irregular figure demonstrates a perverse mind.

Flatland remains congruent in its discussion of perspective and perception. Alluding to Fechner, A Square describes the individuals in his realm as “very much like shadows” (3). A Square repeatedly appeals to the readers, who are “blessed with shade as well as light” and “endowed with a knowledge of perspective” (14). A Square sees the extreme extent of limitation when carried to Pointland by a dream vision. In Pointland, the king, a point, “is himself his on World, his own Universe” (75). The king of Pointland “plumes himself upon the variety of ‘Its Thought’ as an instance of creative Power” (76). A Square is distraught by the narrow view of the point, and perhaps more distressed because “that Point is a being like ourselves” (75). Each dimension that A Square explores is a reflection and shadow of the dimensions both higher and lower to it. Yet, each realm is its own distinct dimension. The distinction outlines dimensional limitation. In order for Flatlanders to distinguish one another, they may feel, see, or hear other inhabitants. The ability to distinguish by seeing is attributed to the upper class, while Feeling is attributed to the lowest classes. The separation is evident, as “none who in early life resort to ‘Feeling’

will ever learn ‘Seeing’ in perfection” (21). A two-dimensional being limited by his own dimensions will not see three dimensions to perfection, which is demonstrated in *Flatland*. A Square has trouble understanding the concepts of “light,” “shade,” and “perspective” (69). He can only learn and understand in terms of his own dimensionality.

How, therefore, can a two-dimensional creature understand the nature of a three-dimensional world which he cannot, by limitations of his body, entirely experience or comprehend? A Square believes that “the narrative of [his] adventures” serves as a means to explicate and understand his own experience” (74). The text itself functions to reinforce A Square’s faith and rendering of a third dimension by embedding the text with groupings of three. When asked how to distinguish one another, A Square responds, “The answer is threefold” (14). The mating ritual in Lineland involves three individuals that perform a musical custom intended to bring the “three Lovers into closer harmony” (47). The arrival of the three-dimensional being, a Sphere, occurs at the end of the fifteenth chapter of the book, the fifth multiple of three. The ending of that same chapter concludes in a descriptive trifecta, indicating time and number in terms of three:

I glanced at the half-hour glass. The last sands had fallen. The third Millennium had begun. (54)

This turn of Millennium serves as the turn of the novella. In the remaining text, Abbott utilizes vivid and descriptive language to explain events, settings, and dimensions. The chapter following the fifteenth indicates the new precedence of word: “How the Stranger Vainly Endeavored to Reveal to me in Words the Mysteries of Spaceland” (55). The chapter returns to A Square’s previous encounter with the king of Lineland, in which the king asks the square to give description of a two-dimensional world: “I beg you to describe it to me in words” (50). A Square offers, “Instead of any lucid description” of his own world, “the numbers and sizes” of the king’s subjects (51). The use of numbers and sizes does not help the king of Lineland understand or mentally illustrate the nature of Flatland. The king’s inability to understand becomes, again, a question of representation. As mentioned previously, the mathematical structure of representation cannot properly describe the abstract fourth dimension. Additionally, the geometric system, as shown by Abbott, cannot function due to the limitation of perspective. The king of

Lineland, adapted to his own dimensionality, cannot see any other dimension to perfection; therefore, the king must rely on imagination, which is more easily prompted by words, or “lucid description.”

Words are a source of apprehension in Flatland because of their ability to revolutionize. According to A Square, Flatland is “somewhat dull” in both “the aesthetic and artistic point of view” (25). Artistic practices did not form in Flatland until the Colour Revolt, which consisted of figures painting themselves colours. This revolt threatened the structure of society but also enriched Flatland’s culture and mathematics: “Immoral, licentious, anarchical, unscientific – call them by what names you will – yet, from an aesthetic point of view, those ancient days of the Colour Revolt were the glorious childhood of Art in Flatland” (27). More importantly, the Colour Revolt gave life to the words of Flatland: A Square describes the effect of the Colour Revolt on language:

How great and glorious the sensuous development of these days must have been is in part indicated by the very language and vocabulary of the period. The commonest utterances of the commonest citizens in the time of the Colour Revolt seem to be suffused with a richer tinge of word or thought; and to that era we are even now indebted for our finest poetry and for whatever rhythm still remains in the more scientific utterance of these modern days. (27)

The Colour Revolt threatens the more “scientific” language of Flatland, mathematics, to become “unscientific.” However, the language of Flatland, the language of mathematics, is enriched by the colour revolt, introducing poetry and rhythm to realm of mathematics. The second half of the novella proves the enrichment of language. A Square not only uses vivid language, but even describes himself as a Flatland Prometheus (70). A Square, through literary allusions and descriptive language, inserts narrative and imagination into a world controlled by the scientific vocabulary of geometry.

One may argue, by examining both the word and deed of A Square, that words and narratives do not successfully function in the realm of mathematics. A Square fails to describe his world to the king of Lineland. However, A Square does not describe his world in vivid language; rather, he describes the world before him in geometric and arithmetical terms. The occurrence does not prove the inadequacy of language, but the inadequacy of mathematical terms to describe an abstract concept to a being of limited perspective. The mathematical description could not evoke a response in the imagination. When writing

his treatise, for instance, A Square finds himself “hampered by the impossibility of drawing such diagrams as were necessary for my [A Square’s] purpose” (80). Diagrams can only be made within the understanding and confines of one’s own dimensions. A two-dimensional creature cannot draw a figure of three dimensions. Therefore, A Square writes a treatise to effectively convey the nature of a higher dimension, while attempting to avoid persecution and the mockery of Flatland society: “I spoke not of a physical Dimension, but of a Thoughtland whence, in theory, a Figure could look down upon Flatland” (79). A Square’s “adventures” and creation of “Thoughtland” are only more fitting following his experiences in the third dimension. Although A Square first sees the third dimension clearly, it later “did not seem to me [A Square] quite so obvious now” (77). He experiences the third dimension in waking, while the other dimensions he experiences in sleep. The waking vision of the third dimension begins to fade “like the image of a half-grasped, tantalizing dream” (78). The Sphere of the third dimension describes four-dimensional creatures as “visions arose from the thought. . . from the brain; from the perturbed angularity of the seer” (73). To experience a momentary glimpse of a higher dimension is to experience a momentary perturbation of the mind, or an irregularity of thought.

The process of thinking and higher function of thought becomes important, as seen in Charles Howard Hinton’s *A New Era of Thought* (1888), published four years after *Flatland*. The exploration of a higher dimension, or the attempt to describe the fourth dimension, was an attempt to reach a higher state of mind and momentarily “reveal to it the narrow limitations of Pointland, and lead it up to something higher” (Abbott 77). At the beginning of *Flatland*, A Square finds that his “mind has been opened to higher views of things (3). Hinton also believes in achieving a higher state of mind, and even states that “there is really no more difficulty in conceiving four-dimensional shapes, when we go about it the right way, than in conceiving the idea of solid shapes, nor is there any mystery at all about it” (6). However, the ability to conceive those shapes must be “brought into consciousness” (6). Hinton argues that all humans have the ability to conceive higher space, but this conception occurs when “a new horizon opens” in the mind (6). In his introduction, Hinton uses *A New Era of Thought* to “choose the best means of liberating our minds from the limitations imposed on it by the particular conditions under which we are placed”

(xiv). Hinton praises pioneers of the fourth dimension, like Gauss and Lobachevsky who “have inaugurated the four-dimensional era” (7). This new era “is an attempt, in the most elementary and simple domain, to pass from the lower to the higher” (xiv). To form a higher state of mind, or to alter its “horizon,” the mind must see the world in terms of arrangements made of units. Hinton immediately removes number as a means of units, because numbers are intangible and “incapable of definition” (19). Hinton even further criticizes numbers as a representational system:

I would divide studies into two classes: those which create the faculty of arrangement, and those which use it and exercise it. Mathematics exercises it, but I do not think it creates it; and unfortunately, in mathematics as it is now often taught, the pupil is launched into a vast system of symbols – the whole use and meaning of symbols (namely, as a means to acquire a clear grasp of facts) is lost to him. (19)

Hinton does occasionally use diagrams, but he prefers to work in Thoughtland. Hinton coaxes the mind out of numerical logic and into a state of imagination by asking the reader to imagine situations. Hinton finds that to open the mind to a higher horizon includes opening the mind’s eye, as the physical body and eye are limited to three dimensions. It is only after developing “our power of perception” (69) that we can contemplate the fourth. A Square serves an example to Hinton’s work. A Square suddenly gains consciousness of a higher dimension, or higher state of mind, but the descent from the glimpse opens the mind to the evils of one’s state of being: “I knew that Flatland was my doom. One glimpse one last and never-to-be-forgotten glimpse I had of that dull level wilderness -- which was now to become my universe again – spread out before my eye” (74). Hinton fails to address the negative effect of opening the mind to one’s dimensional limitations. While one may find a glimpse of a higher level of existence, or thought, that same glimpse renders one miserably conscious of limitation and unattainable possibility. For A Square, the flatness of his world after the glimpse of a higher existence drives him to madness and rebellion.

Where Hinton offers a way to open the mind to new horizons without suggesting a direction in which the mind should move, only describing a movement from “lower to higher,” Fechner and Abbott suggest the fourth direction of space. In “Space has Four Dimensions” (1846), Fechner satirically

reiterates the common thought of space as threefold: “The philosopher counts: perception is threefold, God is threefold, man is threefold, and likewise space is threefold” (132). However, “the philosopher forgets so thoroughly about time and space that they in turn forget about him” (132). Fechner describes the passage of three dimensions into, or through, the fourth by means of time:

Like the shadow man, we say, “There is time and with time everything changes, ourselves included.” What is the basis for this observation? As our space of three dimensions moves through the fourth dimension, we perceive only the passage of time and the changes that occur. (134)

Abbott Abbott also addresses time, but not as directly as Fechner. Although A Square cannot travel through time, or else he would have escaped from prison, he does suggest the rebellion against dimensionality. If Abbott Abbott’s novella follows the logic of Fechner, then A Square advocates the rebellion against the limitation of time. Hoffmann, though entirely logical mathematically and theoretically, fails to consider the nature of Thoughtland. The Sphere notes to A Square that four-dimensional beings have been encountered in the three-dimensional world. For this to be true, necessity dictates that these creatures travel through space *and* time. However, Thoughtland may simply follow the notions of Hinton, and the fourth dimension may truly be a place where time is suspended because thoughts and abstract notions do not fall under the construct of time. However, Fechner’s construction of time may provide insight to Thoughtland’s structure: “Everything that we will experience is already here, and all that we have experienced is still here” (134). Regardless, each theory takes time into consideration, whether time is the all-encompassing eternal or the strictly linear. Each theory must also take into consideration the passage of time and the movement of a body through it. Fechner notes that “almost all motion in nature is back and forth” and the movement into the fourth dimension will ultimately lead to “retrogressing” (136).

The issue, then, extends beyond congruence and perspective into one of time and rebellion: A Square advocates a rebellion against limited dimensionality, or against the limitation of seeing and perceiving, and hence, a rebellion against limited thinking: “I will endure this and worse, if by any means I may arouse in the interiors of Plane and Solid Humanity a spirit of rebellion against the Conceit which

would limit our Dimensions to Two or Three or any number short of Infinity” (70). Fechner’s two works suggest a rebellion against the independent other, or a simple distinction of oneself from the similar other, or shadow. To distinguish oneself from one’s own shadow is to distinguish oneself from dimensional limitations – not just from space, but from time. To rebel against time, one must change the past, which inevitably changes the future, present, and future present. Distinction and rebellion, the ascent into Thoughtland, begins by distinguishing oneself from the past, which means changing it. Mathematicians like Riemann, Helmholtz, and Poincaré distinguished themselves by testing and questioning Euclid’s principles of geometry, a feat that required a small leap into the past, though not physically, instigated by a momentary abnormality of the mind, or a glimpse into a higher mental horizon, hyperspace. Abbott Abbott’s protagonist, A Square, is both unsuccessful and successful at rebellion, as he lacks the ability to alter the past, but has the momentary perturbation of the mind. A Square also is hopeful of the elimination of limitation, promotes rebellion and perturbation of the mind: “I exist in hope that these memoirs, in some manner, I know not how, may find their way to the minds of humanity in Some Dimension, and may stir up a race of rebels who shall refuse to be confined to limited Dimensionality” (Abbott 82). However, the work of Fechner, Abbott, and Hinton instigate a rebellion against time that begins with H.G Wells, in *The Time Machine*, and endures through the modern sub-genre of science fiction known as steampunk. After considering the “memoirs” of A Square, the preface of *Flatland* concludes, “On the one hand, ‘this can never be,’ and on the other hand, ‘it must needs be precisely thus, and we know all about it’” (x). On the one hand, a singular moment of madness to alter a passing, or passed, moment can never be; on the other hand, a rebellion against time must function precisely under these conditions.

III. The Steametric Rabble: or, Navigating Thoughtland with Brass, Math, and Steam

Hodder’s novel serves as an example of not only the possibilities of time, but also the issues of perception and perspective that the non-Euclidean geometers outline. The existence of Francis Burton in Victorian England renders the existence of Francis Burton in steampunk England. Fechner, with his description of shadows, and Helmholtz, with his gazing globes, are a reminder that if one Burton exists, so must the other. To exist in our known reality is to also exist in the mirror or shadow world. Fechner

argues that “neither a genius nor a fool can behave differently than his shadow.” Burton appears to prove this point, but in a steampunk, non-Euclidean manner. Burton, in the mirror world, or the fictitious London of the steampunk novel, simply behaves as he would if the Burton of the non-shadow world were placed in alternative London. The novel is not simply depicting a shadow Burton working against the historical truths of his man, but a shadow working as if its man were placed under the same conditions and limitations, or non-limitations, as his shadow.

As dramatized in Hodder’s *The Strange Affair of Spring-Heeled Jack*, steampunk encompasses nearly every concern a steampunk may have with machinery and limitation, while reflecting the same concerns of perspective and congruence outlined by non-Euclidean geometers. The work combines steampunk’s inherent fear of conformity and its ability to remake objects, including time, while simultaneously accommodating the ideas of acceptable alternate realities and an overall consistent structure of time. Hodder’s novel explores the psychological tension between the freedom and desire to rebel against history and time in order to remake an identity and perform the reality of such freedom. Although Hodder’s characters may be historically defined, their identities are fluid and have the capability, to an extent, of alteration. The characters’ identities, however, do present certain limitations of fluidity, just as time must work under confines of its own structure. The desire to “find your place” (Hodder 351) in the present inevitably leads to a contemplation of the past and the constraints the past establishes.

The novel attempts to show the fluidity of time and identity by juxtaposing the historical figure of Sir Richard Francis Burton and the time traveler Edward John Oxford, or Spring-Heeled Jack. Notably, the Sir Richard Francis Burton of the novel, holding Fechner’s standards, is not the historical Francis Burton, but the Burton of the shadow, or mirror, realm. Both characters, Burton and Oxford, offer differentiating perspectives of time. Burton’s half of the novel emphasizes time as strictly linear. Nearly every page of his account includes a reference to the hour or the minutes it takes to accomplish a task. The Victorian is a man of the present, with a focus on schedule and punctuality. To interact with the past, since he lacks the technology to actually enter the past, Burton must reconstruct the past through memory

(18). Burton's sense of self is constructed from a remembered past that he cannot change. Memory serves as the Victorian equivalent to a time machine, and after momentarily time jumping with thought, Burton's "mind re-engaged with the present" (26).

Edward Oxford also constructs himself based on his past, but unlike Burton, Oxford has the ability to travel in time. In an attempt to define himself from the past, Burton does not realize that it is the present that regulates the mind. Where Burton is able to stop reminiscing, as he returns to the present, Edward Oxford has no present to which he can return. Near death, Oxford tells Burton that to find one's place, one must find "points of stability. Things you can associate yourself with. Permanent coordinates" (351). Those permanent points "make us who we are" (351). Oxford mistakenly chooses "an event from ancient history" as his stable coordinate. By attempting to change that part of his history, he "ended up erasing something that made" his identity (351). Hodder includes a quote at the opening of a chapter in which Henry De La Poer Beresford remarks, "Nothing is permanent, least of all the thing you think of as I" (265). Hodder depicts time as fluid, but in that fluidity events happen because time necessitates that those moments happen. Upon his first attempt to stop his ancestor from attempted assassination, Oxford hears a voice shout the surname shared by him and his ancestor. The shout startles Oxford, who then moves the arm of his ancestor, causing his ancestor to shoot Queen Victoria, rather than miss the target. Upon seeing the events, Oxford is in disbelief: "This isn't happening. This can't happen. This *didn't* happen" (248). During their struggle, Oxford's ancestor hopes to "live through history" (247). Oxford's disbelief is understandable, but the remainder of the novel reveals that his ancestor's death was inevitable. Oxford time jumps again, and since a temporal shift disallows him to jump to the same moment and location in time, Oxford can only shout at himself and his ancestor: "*It was me*, thought the time traveler. *The distraction; the shout and the flash. I looked up at myself here on the hill and in doing so moved my ancestor's arm*" (262). Oxford even time jumps again to warn his ancestor as a young boy, instigating his ancestor's crime (270). The string of events demanded that Oxford's ancestor attempt assassination, Oxford attempt to stop his ancestor, and then Oxford distract another version of himself who attempts to

rectify the first failed endeavour. To Oxford, the alteration of history “didn’t happen,” but the construct of time dictates that the events happen precisely thus.

The reaction Oxford has to the newly constructed Victorian England is much different than Burton, and the different reactions illustrate the process of remaking an identity, both of time and individual, and the psychological/temporal disturbances enacted during the remaking process. As Oxford begins to create an alternate path of history, Burton had a feeling that “he was a divided identity; that two persons existed within him, ever fighting to thwart and oppose the other” (115). With each moment in which he diverges from the history that Oxford believes to be true, Burton experiences “an intensification of the feverish sensation that his personality was split” (140). Oxford calls himself a historian and believes that the history Burton experiences is incorrect. Burton begins to understand that “Jack’s perception of time” was due to the fact that he was not native to Victorian England. Yet, just as Oxford is not native to Burton’s time, Burton himself does not feel native to either England or to himself: “*I am changing*, he thought. *I hardly know myself*” (142). The clairvoyant that Burton patrons tells “of a time that is not a time. Of a time that could be. No! Wait. I do not understand. Of a time that *should be?*” (149). Burton appears almost as a Jekyll/Hyde character, where time instigates his transformation of identity. The image once again brings to attention the perturbation of the mind, which, for Burton, is a split identity. However, the two identities are inextricably attached to the time. McGurl would describe both Burton and Jekyll/Hyde as higher-dimensional beings, as their identity is both “evolving” and “becoming.” The movement aligns with the “back and forth” motion that Fechner outlines (136). For Burton, the disturbance of time evolves his possible identity choices, which then effects the “becoming” of his character.

Oxford, psychologically and developmentally, works in inverse congruence with Burton: Oxford, in this manner, transforms into the mirrored form of Burton. Oxford believes that the alternative timeline he creates is “desperately wrong,” and, therefore, desperately attempts to “restore” it to its original condition (327). However, Oxford’s attempt to restore the past, as he knows it, is not simply an attempt as an historian to correct his mistake, but an attempt to restore his own identity. Oxford explains

time as a rope, and when he kills his ancestor, the rope was cut at that moment in time. The future as Oxford knows it then becomes a piece of rope separated from its past. The two pieces still exist but are now separate from one another. Therefore, Oxford's existence in this separated path begins to create a new form extending to a new, altered future: "For us, everything after the death of the Original Oxford must be written anew. There's nothing there for me to jump forward into" (261). By dedicating the first half of the novel to the "becoming" of Burton, one may then see the unbecoming of Oxford illustrated in its remainder. Burton's identity may take a number of possible paths, but Oxford suffers a complete loss of self which exists in the year 2162, and, later, a loss of existence. The two characters demonstrate a perturbation of identity, but where Burton's feeling of psychological tension stems from possibility, Oxford's mental instability stems from sudden impossibility. The opposition, yet congruence, between the two is reminiscent of Hinton. Both characters take opposite journeys, taking divergent paths, but meet again at the same location, both physically when they interact with each other, but also in a realm of "becoming." Burton's "becoming" is the "positive being," while Oxford's "becoming," an unbecoming, is the "negative being." As mentioned with the previous discussion on non-Euclidean geometry, should one individual evolve or diverge from the other, its reflection must evolve with it, or diverge in a congruent path. Logically, then, if Burton were to become, Oxford must unbecome, as a mirrored individual must take the opposite, inverse direction of his man.

Despite Burton and Oxford's simultaneous autonomy and interdependency, and the fluidity of their identities, both characters are limited by the confines established in the novel and inherent in time, stressing the need for a larger, ordered construct to stabilize mind, identity, perspective, and the perception of time. Oxford connects his loss of self to a loss of "permanent coordinates" (351). One could look at Oxford as having three sets of coordinates initially: He has the point in time in which his ancestor commits treason, the self he knows in 2162, and the end of his natural life in his newly constructed Victorian England. When time-jumping, Oxford assumes that the past is fundamentally unchangeable, or stable. He also assumes that his self in the year 2162 is also unchangeable, as his presence causes permanence. Oxford discovers that both the past and the future are changeable; however, to construct a

stable identity, one must accept that specific moments in time lay the foundation of the human identity. To Oxford, these defining moments are “permanent coordinates,” or, “points of stability” (351). The novel depicts Oxford’s loss of stable coordinates, his future and his past, and finally his discovery of a single stable coordinate — his death. Before his death, as he realizes the need for stable coordinates, or defining moments of time, “the madness died from his eyes” (351).

Opposing the unstable Oxford, who rejects the incorrectness of time but ultimately accepts the necessity for certain events to exist, Burton demonstrates ultimate acceptance. Burton first says that “time was a key element in understanding Spring-Heeled Jack” (141). Burton, a man of the present, only understands that the future he once inhabited has been changed through the perspective of Oxford. Yet, Burton cannot accept that perspective: “The problem, Oxford . . . is that although the future isn’t what it used to be, I like it the way it is” (351). Darwin, within the novel, sees this as “the human organism selecting its own path of evolution” (351). Burton’s ideology refers back to the beginning of the novel in which he reminds the woman no longer destined to be his wife, “When what you want doesn’t happen, learn to want what does” (138).

Although Burton appears to accept the new, alternate future, the conclusion of the novel casts doubt in both the reader and characters. Burton knows that “Oxford changed the course of history,” and that “his presence sent out ripples that altered everything” (360). The London that Burton sees is “only a superficial resemblance” to the London Oxford knows. Swinburne, the Libertine poet and partner to Burton, notes that change in individuals: “Our time has presented us with different opportunities and challenges; we are not the same as the people recorded in Oxford’s history” (360). When Burton walks into the London street, he is overwhelmed by a sense of time and place: “The thick fog embraced him. It was silent. It was mysterious. It was timeless. *It makes it seem as if*, he thought, *my world doesn’t really exist*” (364).

Oxford’s coordinates, prior to accidentally murdering his ancestor, were located in the year 2162, where his known self was already established and present. After creating an alternative timeline by cutting the cord of his initial timeline, Oxford’s coordinates are lost and replaced by an unstable,

changeable future. The steampunk Darwin of Hodder questions “whether one future replaces the other or if they run concurrently” (351). Oxford’s cord theory suggests a future with no past, and a past with a new future. Burton finds “the future is always uncertain,” and questions the validity of his present. Hodder answers his Darwin and his Burton by including an appendix, subtitled “Meanwhile, in the Victorian Age.” The appendix validates the existence of both the historical truths as we, in the current present, know them, and the alternative truths, or the fictitious history, which Hodder creates. Within the novel, Henry De La Poer Beresford, or “The Mad Marquess,” poses the question of choice with time:

Every time we are faced with a choice, and we are faced with
them every minute of every day, we make a decision and follow
its course into the future. But what of the abandoned options? Are
they like unopened doors? Do alternative futures lie beyond them?
How far would we wander from the course we have steered were
we to go and, just once, open Door A instead of Door B? (243)

The question posed by Marquess proves intriguing, as it is an epigraph to the chapter instead of placed within the established narrative. The epigraph itself, which is assumed to have been spoken outside of the written narrative, is itself an unmade choice of the author existing outside of the author’s chosen narrative. Hodder’s chosen epigraphs illustrate a past and a present, as well as unmade and made choices, existing simultaneously next to one another. Where Hodder clearly identifies that the alternative pasts and futures exist concurrently, it is the reminiscent, unmade choices that make Burton question the existence of his world. Does his world really exist if it is constructed by the unmade choices and untaken doors of another alternative self?

Hodder’s novel does not, and perhaps cannot, provide an answer. Rather, Hodder presents a seeming chaotic novel that ultimately reveals a definite structure of physical space and space of the mind. Hodder and non-Euclidean geometers offer a fluidity of perspective, identity, and representation that recognizes a need for its questioning, but also accounts for established mechanisms and structures. Steampunk offers the fluidity of time that both understands the need for time and history to be altered in order to help humans form their own identity and distinguish themselves from the past, but it also works

within the confines of the internal mechanism of time itself: Non-Euclidean geometers recognize a need to question established principles of geometry with imagination, but also try to work within the bounds of Euclidean space. Burton asks Swinburne, “People should have the right to shape their own destiny, don’t you think?” Swinburne replies, “Isn’t that a contradiction, Richard?” (347).

Steampunk attempts to foster the illusion of the right to defy time and destiny, but dimensional limitations still place restrictions on perception and representation. In the novel, Swinburne realizes that time may be defied through words. Thoughtland, the world of imagination and words for geometers and higher-dimensional characters, becomes a chaotic space where individuals may see their own “becoming” and their shadowed selves: It becomes a place where men and time may see what they could become, but also see that both can only become what they are destined. Thoughtland allows for the unraveling of the self and time. However, to ascend into Thoughtland is to temporarily, or permanently in the case of Oxford, lose one’s identity:

He fragmented.

All the elements that had made Edward Oxford the man he was separated from one another and drifted apart. Decisions taken were unmade and became choices; successes and failures reverted to opportunities and challenges; characteristics disengaged and withdrew to become influences.

He lost cohesion until nothing of him remained except influences.

He lost cohesion until nothing of him remained except potential. (344)

The momentary perturbation of the mind required to rebel against time and ascend into Thoughtland is an instability caused by the loss of the self. To remain in a state of rebellion, a state of unraveling, is to entirely lose all aspects that compose one’s identity. Like A Square in *Flatland*, Burton sees, only momentarily, the existence of higher dimensions through the medium of time travel and altered histories.

Unlike Oxford, both Burton and A Square do not become mad or unmade. In Hodder’s novel, the Libertines, a group of artists who hope to break limitation barriers, ask, “What if you banish all the limits that define YOU? What then? Who are you?” (241). After the unraveling of the self in Thoughtland, an individual must return to a world of limitations and remake the self. The madness must be a singular moment, not a prolonged condition, otherwise we remain in a state of “retrogressing” like Oxford, instead

of the Jekyll and Hyde motion of “back and forth” like the stable Burton. Identity and mind must move as fluidly as time: it must both accept and reject limitations of time and space in equally evolving terms and systems of representations. Both *Flatland* and *Spring-Heeled Jack* include characters writing their visions and histories in words. Burton has a dream in which Isabel burns his journals. With each journal burned, “Burton felt a chunk of his existence melting away. She picked up another volume, fed it to the fire, and hissed in satisfaction as another part of him was turned to ashes” (169). When the journals are completely burned, “Sir Richard Francis Burton was consumed, reduced to an empty shell of deeds done, the man himself removed” (169). Isabel tells Burton that he “must be rewritten” (169). The history within the journals becomes nullified by the remainder of the novel, as Burton’s history is “rewritten,” but also because the journals would have told the reader of the *deeds* of man, not *of* the man. Hodder illustrates the tension between written history and the history of possibilities. The burning of Burton’s journals signifies the creation of possibilities, rendering Burton more human than historic. To be human is to feel the constant internal tension of infinite possibility. Through definitive structures with significant flexibility, time, under the power of man, adopts the characteristic of possibility. Time remakes itself and transfers the possibility of a remade identity to those under its manipulation. As Forlini describes, “our fate is tied to the fate of the things we make — the implication is that with certain kinds of making, or more importantly, re-making, we renew/remake ourselves” (78). Time itself becomes embedded in the human identity, and to remake time is to entirely remake the human mind and human identity.

VI. Conclusion: The Made and Unbecoming

Burton’s journals tell a narrative of what *became*, while Hodder’s novel offers a narrative of what *became*, what *could become*, and what *could have become*. Non-Euclidean narrative constructs a fluid realm where madness becomes just as valid as sanity, an alternative past as truthful as a historical past, words as descriptive as geometry, and the imagination as reasonable as logic. By accepting this fluidity, both geometry and literature work symbiotically to enrich and understand the other — for “neither a genius nor a fool can behave differently than his shadow.” Steampunk narratives share the non-Euclidean idea that geometry may not simply represent a concrete world through numbers that have specific

meaning attached to them; instead, geometry may explain a Thoughtland where imagination can describe abstract constructions, tell narratives of human possibility and thought, and tell a narrative about time itself.

The Strange Affair of Spring-Heeled Jack illustrates a transference of identity through manipulation. In steampunk, the human attempts to personalize an object, reassigning a portion of the human identity to the object. Simultaneously, as the object absorbs a new identity, the object also transfers its own identity to its human. In this narrative of time travel, time itself forms a new identity — manipulated and manipulator. Time, created as a means for man to manipulate and dominate the abstract, uses its established system to then manipulate and transform that which placed it within the confines of a system. Similarly, man attempts to personalize his technology, building it to suit his own needs. However, man forgets that in remaking objects and time, both remake the identity of man. The boundaries between object and human are obscured, as time, thought of as an object, remakes human identity.

This obscuring of borders between man, time, and technology clearly illustrates the non-Euclidean concepts of congruence and representation. The evolution of non-Euclidean geometry and steampunk demonstrate a mirroring inherent in time and nature. Where the geometers hoped to alter the organization and limitations of geometry by means of imagination, steampunk hopes to restructure the nature of imagination by means of well-ordered mathematics. In doing so, already-established terminology must be repurposed to describe a new system. Yet, the new system for both still remains difficult to describe and represent since both manipulate the intangible human thought and human identity. Steampunk and geometry attempt to depict the fluidity of human thought and identity by placing both into a structure that man can imagine through words and organize with the logic of geometry. The fluidity and remaking of an identity can only be represented by a system just as able to be remade.

This discussion of higher-dimensional geometry alongside narrative, especially with the texts that have been examined, is by no means complete. While this examination heavily outlines time, space is another aspect of mathematical-narrative that should be explored in-depth. The significance attached to Victorian London in steampunk is a topic that could easily be expounded upon in another examination.

However, the increasing amount of steampunk that does not take place in Victorian London is also significant. Regardless, the shape and importance of space, as outlined by non-Euclideans, could engage with this examination and other possible discussions in significant manners. Even the passage of both the reader and the book through space, as well as time, could be discussed thoroughly. However, this analysis focuses specifically on the interaction between time, identity, object, and human thought. Admittedly, space, either in its standard shape or non-Euclidean form, is marginalized in this project.

[This excluded section discusses other possibilities of examination and issues that were not addressed]

Even with these possible examinations, the paths that were not taken in this particular project, each should take into account, at the very least, the idea of congruence. The interaction of these two groups of people and their mirroring across time cannot be ignored. Their shared thread is that of human possibility and impossibility, alongside the powers of human thought and imagination. Both find themselves unavoidably embedded in a structure that confines the mind and body, but both attempt to bend the mind and body to test the limitations of both structure and thought.

Never was the interaction between thought, time, representation, perception, and limitation as strong as when one creates and imagines in the mind's eye. While reading a book you are passing through time and space. Yet, the speed at which you think and imagine is not measured by the speed in which a page is turned, nor the minutes in which both you and the paper pass through time, or the length in which you pass through space. Words are confined to a page, the brain confined to a skull, the body confined by time, and time organized by our constructs — while thought and imagination remain unbounded and unlimited. Narratives of time travel are not simply illustrating the manipulative power of time and the limitation of man, but they are forcing readers to recognize their own limitations and the unbounded nature of the imagination.

By reading these words you have temporarily passed a single boundary, opened a mental horizon, and ascended into Thoughtland. However, the laws of motion and principles of mathematics must also take effect. *Now* is the time of your descent.

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Annotated Bibliography

Abbott, Edwin Abbott. *Flatland: A Romance of Many Dimensions*. New York: Dover, 1992. Print.

This served as one of my primary texts in the thesis. This serves a prime example of 19th-century literature that couples mathematics with narrative.

Bowser, Rachel A., and Brian Croxall. "Introduction: Industrial Evolution." *Neo-Victorian Studies* 3.1 (2010): 1-45. *Journal of Neo-Victorian Studies*. Web. 15 Feb. 2014.

This article serves as a great introductory piece not only to the issue of *Neo-Victorian Studies* that focused solely on steampunk, but contributes to the overall nature and importance of steampunk culture. Its focus on objects and mechanisms forecasts for the remainder of the issue and gives relevance to the period of industrialization in which steampunk inhabits.

Butler, Andrew M. "Thirteen Ways of Looking at the British Boom." *Science Fiction Studies* 30.3 (2003): 374-93. *JSTOR*. Web. 9 Nov. 2014.

This article demonstrates the economics of science fiction in the late 20th century. It helps to economically understand why the popularity of science fiction, especially steampunk, decreased until the turn of the century. It also helps to situate steampunk writers between descriptivist and prescriptivist sectors, illustrating the work being done on both sides of the market.

Cherry, Brigid, and Maria Mellins. "Negotiating the Punk in Steampunk: Subculture, Fashion & Performative Identity." *Punk & Post-Punk* 1.1 (2012): 5-26. *RILM Abstracts of Music Literature*. Web. 3 Mar. 2014.

A large part of steampunk is the actual term "punk" and how this section of the term plays out into reality. These authors graciously offer the various debates between whether steampunk is actual punk or not. More importantly, it explores the commodification of steampunk, and whether commodification has actually taken the punk out of steampunk. Punk refers to deviation and subversion of a dominant culture, and these authors offer reasoning as to how steampunk, as a subculture, subverts dominant culture.

Clifford, William Kingdon. "On the Space-Theory of Matter." *Beyond Geometry: Classic Papers from Riemann to Einstein*. Ed. Peter Pesic. Mineola, NY: Dover, 2007. Print.

This article discusses an idea of congruency, which plays a large part in this paper. This is a seminal, mathematic work that gives explanation to higher dimensional space. It also presents the idea that perception plays a key role in space, and the perception of both a person in a mirror and outside of it are both correct in their assumptions and perceptions of the world.

Clifford, Wililam Kingdon. "The Postulates of the Science of Space." *Beyond Geometry: Classic Papers from Riemann to Einstein*. Ed. Peter Pesic. Mineola, NY: Dover, 2007. Print.

The postulates provide a more in-depth look at congruency and the manifolds of higher-dimensional space.

Cotton, James Sutherland. "Science: Some Books on Geometry." *The Academy* 21 Oct. 1893: 345. *British Periodicals*. Web. 27 Apr. 2015.

Cotton's book provides a very simplistic explanation of science and geometry at the time, and offers simple explanations of some of the more complex ideas of hyperspace.

Dunnington, Waldo G. *Gauss: Titan of Science*. New York: The Mathematical Association of American, 2004. Print.

This is primarily a biography of Gauss, the grandfather of hyperspace. It includes letters written between him and his colleagues. I've used the letters to show the fear and hesitation that mathematicians faced at the time, since hyperspace was such a new and abstract concept.

Fechner, Gustav. "The Shadow is Alive." Trans. Hans G. Fellner and William F. Lindgren. "Gustav Theodor Fechner: Pioneer of the Fourth Dimension." *The Mathematical Intelligencer* 33.3 (2011): 130-2. *Academic Search Complete*. 12 Oct. 2014.

This is interesting in that Fechner may be the first mathematician to actually construct a narrative, with a character, in a mathematical journal. He uses the shadow and its counterpart as congruent characters. It matches the idea of mirror worlds and the idea that there is always a mirrored self that is just as legitimate as the person outside the mirror.

Fechner, Gustav. "Space has Four Dimensions." Trans. Hans G. Fellner and William F. Lindgren. "Gustav Theodor Fechner: Pioneer of the Fourth Dimension." *The Mathematical Intelligencer* 33.3 (2011): 132-7. *Academic Search Complete*. 12 Oct. 2014.

This a complementary piece to "The Shadow is Alive." This article is more scientific, but still retains the narrative style of the other article.

Ferguson, Christine. "Surface Tensions: Steampunk, Subculture, and the Ideology of Style." *Neo-Victorian Studies* 3.1 (2010): 66-90. *Journal of Neo-Victorian Studies*. Web. 12 Feb. 2014.

This article primarily focuses on subculture, and references Hebdige. Ferguson examines the evolution and meaning of clothing and style, as well as the integration of objects into style and fashion, to comment on the success of steampunk to subvert dominant culture and establish itself as a subculture.

Forlini, Stephani. "Technology and Morality: The Stuff of Steampunk." *Neo-Victorian Studies* 3.1 (2010): 72-98. *Journal of Neo-Victorian Studies*. Web. 12 May 2014.

This article instigates my entire essay. It extensively discusses the importance of objects and "thing" in steampunk culture. Objects become a means to reformulate and formulate the identity of the user, as much as the user puts his identity into the object through its construction.

Fowler, David. "Mathematics in Science Fiction: Mathematics as Science Fiction." *World Literature Today* 84.3 (2010): 48-52. *JSTOR*. Web. 14 Oct. 2014.

This article stipulates that all mathematics functions as a form of fiction. Since mathematics explains the world, it automatically constructs a fictitious narrative with a realistic foundation.

Hebdige, Dick. "Subculture: The Meaning of Style." *Critical Theory: A Reader for Literary and Cultural Studies*. Ed. Robert Dale Parker. New York: Oxford University Press, 2012. Print.

This work discusses the political implications of subcultures and the various ways they attempt to subvert dominant culture. Its connections to steampunk are endless.

Helmholtz, Hermann von. "The Origin and Meaning of Geometrical Axioms." *Mind* 1.3 (1876): 301-21. *JSTOR*. Web. 5 Oct. 2014.

This work from Helmholtz is situated at the forefront of the hyperspace movement. These include some of this mathematician's first maxims on hyperspace that are used for many years after its publication.

Helmholtz, Hermann von. "On the Factual Foundations of Geometry." *Beyond Geometry: Classic Papers from Riemann to Einstein*. Ed. Peter Pesic. Mineola, NY: Dover, 2007. Print.

Helmholtz is one of the first pioneers of higher-dimensional space. His work should be included in most essays on this topic because he offers some of the first theories and formulas on space manifolds and how higher-dimensional space can be envisioned.

Hinton, Charles Howard. *A New Era of Thought*. London: Swan Sonnenschein & Co, Ltd., 1910. Print.

Hinton's seminal work offers higher-dimensional space in a new form. More philosophical, his work talks of what happens to the mind when it passes into higher modes of space. His notions of mental horizons allow for my work to progress into perturbations of the mind.

Hodder, Mark. *The Strange Affair of Spring-Heeled Jack*. Amherst, NY: Prometheus Books, 2010. Print.

This serves as my primary modern, science fiction text. It shows a perfect balance between mathematics of the Victorian era, and the psychology embedded in science fiction narratives. The physical print of the text perfectly aligns with the plot to demonstrate a geometrical symmetry that renders two narratives legitimate.

Hyslop, James H. "The Fourth Dimension of Space." *The Philosophical Review* 5.4 (1986): 352-370. JSTOR. Web. 26 Apr. 2015.

Hyslop contributed to the idea of higher-dimensional space, and offered theories and narratives that explained higher-dimensional manifolds and theories

Lock, Simon. "Anachronistic Enactment: Deconstructing Perceptions of Modern Technology." *Leonardo* 46.3 (2013): 282-3. *Academic Search Complete*. Web. 12 Apr. 2014.

This article is important because it combines the nature of steampunk, which is out-of-time technology and objects, with the notion of changing and evolving perceptions. This work also demonstrates how identity changes objects and technologies, just as technologies change the identity of the human connected to it.

McGurl, Mark. "Social Geometries Taking Place in Henry James." *Representations* 68 (1999): 59-83. JSTOR. Web. 2 Feb. 2015.

This article presents an interesting argument on geometry acting as a social marker, or mathematically classifying individuals, in the work of Henry James. Geometry, in this instance, becomes an equation where humans are quite literally entered for computation.

Nevins, Jess. "Prescriptivists vs. Descriptivists: Defining Steampunk." *Science Fiction Studies* 38.3 (2011): 513-8. JSTOR. Web. 9 Nov. 2014.

This work shows the disparity between steampunk writers after the turn of the century and steampunk writers prior to it. The animosity between the two sects mimics the terror and exile demonstrated in the examination of 19th-Century mathematicians. Not only were mathematicians criticizing and exiling one another, higher-dimensional geometries were being questioned by the public.

O'Leary, Michael. *Revolutions of Geometry*. Hoboken, N.J.: Wiley, 2010. Print.

This historian offers great biography on mathematicians and a fantastically thorough history on mathematics. I utilize his research into and translations of letters between German mathematicians. His research shows a deep-rooted fear of humiliation and terror in exploration of higher-dimensional space.

Poincaré, Henri. "Non-Euclidean Geometries." *Beyond Geometry: Classic Papers from Riemann to Einstein*. Ed. Peter Pesic. Mineola, NY: Dover, 2007. Print.

This article is slightly more accessible than the other essay included. This author offered a perspective of a mathematician that came later than the earlier non-Euclidean mathematicians. His work shows an acceptance and safe space that other mathematicians did not receive, indicating the progress of non-Euclidean mathematics as the century progressed.

Poincaré, Henri. "On the Foundations of Geometry." *Beyond Geometry: Classic Papers from Riemann to Einstein*. Ed. Peter Pesic. Mineola, NY: Dover, 2007. Print.

This article gives further explanation to higher-dimensional space. It serves as a supplement to Riemann and Helmholtz.

Riemann, Bernhard. "On the Hypothesis that Lie at the Foundations of Geometry." *Beyond Geometry: Classic Papers from Riemann to Einstein*. Ed. Peter Pesic. Trans. Michael Spivak. Mineola, NY: Dover, 2007. Print.

Riemann is one of the key mathematicians to understand in four-dimensional geometry and hyperspace. Riemann also helps to show the self-awareness of these mathematicians in regard to the skepticism they were being shown. Riemann's graciousness and fear in writing was apparent. He also contributed to space manifolds, and his "deviation of flatness" helps contribute to the idea of social flatness and deviation.

Snow, C. P. *The Two Cultures and the Scientific Revolution: The Rede Lecture*. New York: Cambridge University Press, 1961. Print.

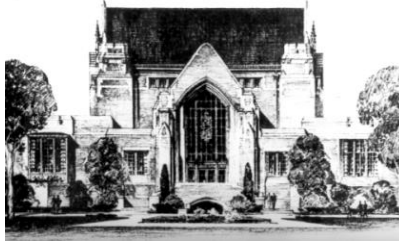
This lecture serves as the foundation and jumping point for the second section of the thesis. Snow's idea that literature and mathematics cannot meet was simply an incorrect statement when examining 19th-Century mathematics.

Steam Powered Giraffe. "Mecto Amore." *MK III*. Steam Powered Giraffe, LLC, 2014. CD.

The steampunk band provides lyrics that work an epitaph, which play on the musings of the previous section of the thesis. After discussing the use of epitaphs as choices made outside of the body of text, this was a conscious choice to apply the same method to my own text.

Tyndall, John. *Advancement of Science: The Inaugural Address of Prof. John Tyndall ... Delivered Before The British Association For The Advancement Of Science, At Belfast, August 19, 1874, With Portrait And Biographical Sketch*. New York: A.K. Butts & Co., 1874. Print.

Tyndall lays another foundation of my argument. He believes literature and science to be inherently connected with one another, and used to enrich one another.



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Describe below what role the Library or archival collections played in the success of your research.
(You may use additional sheets.)

Booth's resources, both the archival databases and its ability to obtain a variety of media, played a pivotal role in my research and the success of this undergraduate thesis. In my preliminary research, I read a number of science fiction novels and read through science fiction magazines that were originally published in the 1980s, and Booth was able to work through interlibrary loans to obtain these unique texts and materials for that preliminary researching. As I began to explore my research topic, I was suddenly pulled into a more mathematic and scientific direction and, thankfully, Booth's sections on physics, geometry, and mathematic theory led me into what I believe to be the best asset of Booth Library, which is its databases and archives. I spent seven months mining the archives and databases, particularly *Academic Search Complete*, *Victorian Database Online*, *19th Century UK Periodicals*, and *JSTOR*. These databases led me from 19th-century tavern songs on steamships and steam arms to articles in mathematical journals about four-dimensional space. These databases were indispensable to my research and gave dimension to my argument.
